# A Note on the Adjustment of Rates

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IN ADJUSTING RATES or standardizing them to remove the effect of certain variables, usually age and sex, a simple procedure is customarily followed. As a consequence, no doubt, little is to be found on the subject in the literature, at least on the elementary aspects.

At present I am engaged in a study that requires considerable adjustment for age, sex, and county of residence (seven counties in New York State), and despite the availability of a computer, much of the arithmetic for the study has to be done with a desk calculator. In laying out the process, I discovered that use of a single standard population permitted several shortcuts.

If an adjusted rate was desired for both sexes combined after an adjustment for age had been made for each sex, one could simply add the two age-adjusted rates and divide by 2. As a corollary, if one wanted to adjust for sex within a specific age group—for example, to make certain that the difference in hospital days between two populations of persons aged 65–69 was not due to the presence of more males in one of them—one simply added the two crude rates for males and females and divided by 2. The reason the crude rates can be used in this way is that it is assumed that there are the same number of people of each sex.

In the actual study, data on utilization are being collected over a period of 4 years, 1969 through 1972, for a study population and a control population of elderly persons on Medicare. There are close to 50,000 persons in each population. The two populations will change a little from year to year as persons die or move away and new persons meeting the criteria for the study reach 65 years of age. The 1969 population is being used as the standard for adjusting the data for each of the 4 years of the study. Otherwise, the data for individual years could not be compared.

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The sex and age distribution of the populations to be compared was as follows for 1969:

| *Sex and age groups* | *Population A* | *Population B* |
|---|---|---|
| Total | 47,665 | 47,138 |
| *Males* | | |
| 65–69 | 9,743 | 7,119 |
| 70–74 | 7,197 | 5,737 |
| 75–79 | 4,056 | 3,827 |
| 80–84 | 1,676 | 1,938 |
| 85 and over | 454 | 842 |
| *Females* | | |
| 65–69 | 9,821 | 8,988 |
| 70–74 | 8,240 | 8,167 |
| 75–79 | 4,454 | 5,709 |
| 80–84 | 1,584 | 3,247 |
| 85 and over | 440 | 1,564 |

These numbers were combined into one age distribution for both sexes, and to save many later calculations, this numerical distribution was converted into proportions adding to 1, following the notion of the standard 1 million.

| *Age groups* | *Persons* | *Proportion* |
|---|---|---|
| Total | 94,803 | 1.0000 |
| 65–69 | 35,671 | 0.3763 |
| 70–74 | 29,341 | .3095 |
| 75–79 | 18,046 | .1903 |
| 80–84 | 8,445 | .0891 |
| 85 and over | 3,300 | .0348 |

### Observed and expected rates for males

| Age group | Observed rates | | Standard population | Adjusted rates | |
|---|---|---|---|---|---|
| | Population A | Population B | | Population A | Population B |
| 65–69.................... | 273.4 | 420.6 | 0.3763 | 102.9 | 158.3 |
| 70–74.................... | 358.3 | 384.7 | .3095 | 110.9 | 119.1 |
| 75–79.................... | 458.9 | 473.0 | .1903 | 87.3 | 90.0 |
| 80–84.................... | 522.4 | 523.2 | .0891 | 46.5 | 46.6 |
| 85 and over.............. | 604.9 | 541.2 | .0348 | 21.1 | 18.8 |
| All ages.............. | 362.1 | 436.4 | 1.0000 | 368.7 | 432.8 |

The direct method of adjusting rates was followed. Proper use of the calculator eliminates the need to write anything down but the adjusted rate. For those who may not have used the procedure since they were introduced to the subject in an elementary biostatistics course, an illustration has been worked out—based on days in the hospital per 1,000 population (see table).

The crude rates for males were 362.1 and 436.4 and the adjusted rates, 368.7 and 432.8. Similarly, the crude rates for females were 268.4 and 347.3 and the adjusted rates, 274.6 and 334.0 (computations not shown). By our method, the adjusted rates for males and females combined were 321.6 and 383.4 ((368.7 + 274.6) ÷ 2 and (432.8 + 334.0) ÷ 2)).

Algebraically, we can represent the procedure this way (which we might have done in the first place):

If $w_1 \ldots w_5$ represent the five weights, $m_1$ the observed rates for males 65–69, and so forth, the standard calculation (but using one set of weights instead of two) can be displayed thus:

$$\frac{w_1m_1 + w_2m_2 + \ldots + w_5m_5 + w_1f_1 + \ldots + w_5f_5}{w_1 + w_2 + w_3 + w_4 + w_5 + w_1 + w_2 + w_3 + w_4 + w_5}$$

$$= \frac{\sum_{i=1}^{5} w_i m_i + \sum_{i=1}^{5} w_i f_i}{2\sum_{i=1}^{5} w_i}$$

$$= \frac{1}{2}\left[\frac{\sum_{i=1}^{5} w_i m_i}{\sum_{i=1}^{5} w_i} + \frac{\sum_{i=1}^{5} w_i f_i}{\sum_{i=1}^{5} w_i}\right]$$

Because the same sets of weights was used for males and females, the adjusted rate for the two sexes combined is the sum of the rates for each sex divided by 2.

A similar procedure was used for the county adjustment. There were seven counties in our study so that a question arose as to how we could be sure that a difference in the rate for hospital days, say, between population A and population B, was not due to the distribution of these populations by county—a difference that would influence the effect of differences between counties in rates. We asked what the rates in A and B would look like if each population had the same distribution by age, sex, and county. (Crude rates will be published along with the adjusted rates.)

Our first approach was to use a different standard population in each county, calculate the expected days (or whatever the variable) for each county for A and B, sum the subpopulations and the expected days, and divide the latter result by the former:

Total expected days (sum for 7 counties) ÷ standard population (sum for 7 counties).

Now if we use the same standard population (SP) throughout, then each county rate—which we want—is the total expected days in the county (EDC) divided by SP (say $EDC_1 \div SP$, the expected rate for county 1). For the total study area, we then have (as in the case of the adjustment for sex):

$$\frac{EDC_1 + EDC_2 + \ldots + EDC_7}{7\,SP} = \frac{1}{7}\left[\frac{EDC_1}{SP} + \frac{EDC_2}{SP} + \ldots + \frac{EDC_7}{SP}\right]$$

That is to say, we add the adjusted county rates and divide by 7.

Because this procedure, elementary as it is, saved us considerable effort, it seems worth a note—or footnote.